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Pre-weaning kid mortality under family-based farming system: Patterns and economic losses in different agro-climatic regions of West Bengal, India

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Goat farming largely gives food, nutritional security and employment generation to millions of small, medium and landless farmers in India. According to the 20th Livestock Census, goat population has shown a remarkable increase of 10.14% as compared to previous census (19th Livestock Census) which reported a negative growth of 3.82% (DAHDF 2014, DAHD 2020). West Bengal ranks 2nd in goat population in the country with a remarkable increase of 41.49% in respect to previous census and 1st in goat meat production (DAHD 2020). The promising population growth shows a good prospect for goat production. But goat production was adversely affected by high mortality of young kids during pre-weaning stage (Petros *et al.* 2014). Several factors such as low birth weight, birth type, sex, parity order, kidding season, age of kid, poor growth rate and negligible milk production by doe were recognized as key constraints directly related with high kid mortality (Chauhan 2019, Kumar 2021). The pre-weaning mortality was possibly the sole largest reason of monetary loss to goat owners and maybe controlled to large extent by improving the feeding and management practices of the kidding flock (Snyman 2010).

Economic returns from goat farming are highly affected due to its morbidity and mortality. Knowledge and adoption about scientific healthcare management practice will help in reducing the mortality of goat (Roy *et al.* 2017, Roy and Tiwari 2017). Further, understanding the pattern of diseases in kid will be helpful in livestock healthcare and management practices in reducing kid mortality. Keeping the entire facet in mind, this study was considered to find out the causes and patterns for morbidity and mortality in pre-wean kid and financial losses under family-based farming system in different agro-climatic conditions of West Bengal, India.

The study was purposively conducted in the state of West Bengal due to its high goat population (2nd) and Chevon production (1st) in India (DAHD 2020). For better addressing the situation, three different agro-climatic regions (i.e. hill agro-climatic region, terai agro-climatic region and lower Gangetic plain) of West Bengal were considered for the study where goat rearing is one of the pivotal livestock enterprises for livelihood of resources poor farmers.

To examine the pre-weaning kid mortality and monetary losses under family-based farming system, an *ex-post facto* study design was applied. Two community blocks each were randomly selected from each region and five villages per community block were selected purposively based on higher numbers of goat breeders. Ten goat breeders per village were randomly selected for data collection who maintains at least two goats as breeding stock. A sample size of 50 respondents from each block and thus 100 respondents each from three agro-climatic regions of the state were selected. In all, 300 respondents formed the total sample size for the study. Farmers engaged in family-based farming system had no records available with them, so data collection were done through personal interview schedule for last three years (i.e. 2016 to 2018) on recall basis. Mortality was calculated from the percent ratio of the kid dead within pre-weaning stage to kid born alive. Patterns of pre-weaning kid mortality were assessed according to sex, type of birth (i.e. single, twins, triplets and quadruplets or more), age (i.e. 1st, 2nd and 3rd month), season (i.e. April–June as summer, July–September as monsoon and October–March as winter), body weight (i.e. ≤ 1 kg, 1.1–2 kg and ≥ 2.1 kg) and parity order (i.e. 1st to 6th onwards).

Analyses of data were done using suitable statistical tools i.e. frequency, percentage and chi-square test. For analysis of the economic losses due to kid mortality, only market rate of the kid was taken into consideration for calculation.

The overall mortality of pre-weaning kids was 12.32% (Table 1). The average mortality rate from birth to weaning was 6.4% in Sanen goat (Khandoker *et al.* 2018) and 10.93% in local Rohilkhandi goat in organized farms (Upadhyay *et al.* 2015). The study also shows that hill agro-climatic region had highest mortality (14.60%) in the study area followed by terai (13.61%) and lower Gangetic plain (9.45%) region. Further, it was observed that mortality of doeling (7.29%) was higher than buckling (5.03%) in the study area. The study of sex and season wise mortality

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Table 1. Pre-weaning kid mortality rate in different agro-climatic regions

Study area	Birth			Kid mortality rate (%)		
	Buckling	Doeling	Total	Buckling	Doeling	Overall
Hill region	1,004	1,024	2,028	134 (13.35)	162 (15.82)	296 (14.60)
Terai region	1,035	1,007	2,042	104 (10.05)	175 (17.38)	279 (13.61)
Lower Gangetic plain	1,312	1,260	2,572	96 (7.73)	147 (11.67)	243 (9.45)
Total	3,351	3,291	6,642	334 (5.03)	484 (7.29)	818 (12.32)

Figure in parenthesis indicate percentage.

shows that female had higher mortality rate than male kids (Tsegaye *et al.* 2013, Upadhyay *et al.* 2015).

Maximum mortality (59.41%) of kid was within the first months after birth followed by second (25.43%) and third month (15.16). Further it was observed that mortality of doeling was higher than buckling in all three months after birth. Comparison of morality in different agro-climatic region in first three months of birth shows that hill region (36.19%) had highest mortality of kids followed by terai (34.11%) and lower Gangetic region (29.70%). Chi-square test shows significant difference due to mortality within first 3 months among buckling and doeling and also between the agro-climatic regions. Maximum kid mortality occurred within 1st month of their age (Upadhyay *et al.* 2015) and further shown that age had significant effect on its mortality (Petros *et al.* 2014).

As the mortality was highest within the first month, therefore, analysis was carried out to find the week-wise mortality of first four week which revealed highest mortality within the first week (41.98%) of birth followed by second (26.13%), third (18.72%) and fourth week (13.17%). Week-wise mortality in kids showed no significant difference within the first month of birth. The study of Petros *et al.* (2014) and Singh *et al*. (2008) further confirms the study.

The study on seasonal kid mortality under different agro-climatic condition shows that highest mortality was recorded during winter (45.35%) followed by monsoon (37.41%) and summer (17.24%) season. Comparison of seasonal kid morality in different agro-climatic region showed that in winter season, the relative mortality percentage was highest in hill region (42.32%) followed by terai region (35.31%) and lower Gangetic plain (22.37%). Similarly in summer season, the relative mortality percentage was highest in hill region (46.81%) followed by terai region (32.10%) and lower Gangetic plain (21.28%). But in case of kid mortality in monsoon season, it was highest in lower Gangetic plain (42.48%) followed by terai region (33.66%) and hill region (23.86%). Chi-square test showed high significant difference due to seasonal kid mortality among buckling and doeling between the agro-climatic regions. The pre-weaning kid mortality was higher during winter followed by monsoon and summer season under village condition of Nadia district of West Bengal (Tudu and Goswami 2015).

The study shows that the kid mortality due to low birth weight was highest among kid born with ≤ 1 kg birth weight (63.57%) followed by kids with 1–2 kg birth weight (26.16%). Maximum kid mortality in ≤ 1 kg birth weight was found in hill agro-climatic region (36.92%). Kid mortality within 1–2 kg and more than 2 kg birth weight was found highest in terai region (40.65%) and hill region (36.92%) respectively. Birth weight between doeling and buckling showed no significant difference in kid mortality among the different agro-climatic regions. Mortality was recorded highest for kids with less birth weight and mortality reduces with increase in birth weight (Zeleke 2007, Petros *et al.* 2014). Birth weight of kids highly affected mortality rate (Zeleke 2007).

Kid mortality was maximum (25.76%) in case of quadruplet birth or more, out of 33 kidding and 132 live kids born under the study (Table 2). Further, pre-weaning kid mortality was 14% in case of triplet followed by 11.71% and 8.67% in case of twin and single kid born respectively. Mortality of the doeling was higher whether it was single, twin, triplet or quadruplet birth. Chi-square test showed no significant difference in pre-weaning kid mortality in relation birth type in the areas under study. Mortality in goat was higher when born in triplets in comparison to twins and singles (Snyman 2010, Petros *et al.* 2014).

Mortality of the doeling was higher in all parity orders (Table 3). The study shows an increasing trend in kid mortality according to increase in parity order in the study area though the chi-square test did not show any significant difference in kid mortality according to parity order. Mortality rate increases with increasing parities in lambs and kid as twinning rate increases with increase in parity order (Zekele 2007, Petros *et al.* 2014). No significant difference was found due to parity order between mortality of doeling and buckling among different agro-climatic zones but Al-Najjar *et al.* (2010) reported that parity significantly affect rate of kid mortality at birth and also from birth to weaning.

Pre-weaning kid mortality due unknown reason was highest (16.50%) followed by diarrhea (13.81%), doe died (13.69%), pneumonia (13.33%) and predator attack (11.37%). Whereas major causes of mortality among buckling were diarrhea followed by pneumonia, doe died, predator attack and unknown causes. Similarly, major causes of mortality among doeling were unknown to the respondents followed by chilling and rain, pneumonia and predator attack. Unidentified causes, goat pox and attack by predators were also added reasons for kid mortality

Table 2. Kid mortality according type of birth in different agro-climatic regions

Type of birth	Birth	Kid-ding	Hill		Terai		Lower Gangetic plain		Sub-total			Total		
			B (a)	D (b)	B (c)	D (d)	B (e)	D (f)	Hill (a+b) plain (e+f)	Terai (c+d)	Lower Gangetic	B (a+c+e)	D (b+d+f)	Total
Single	715	715	9 (39.13)	14 (60.87)	5 (20.83)	19 (79.17)	4 (26.67)	11 (73.33)	23 (37.10)	24 (38.71)	15 (24.19)	18 (29.03)	44 (70.97)	62 (8.67)
Twins	3152	1576	54 (45.00)	66 (55.00)	41 (34.17)	79 (65.83)	42 (37.50)	70 (62.50)	120 (34.09)	120 (34.09)	112 (31.82)	137 (38.92)	215 (61.08)	352 (11.71)
Triplets	2643	881	66 (44.90)	81 (55.10)	53 (43.09)	70 (56.91)	46 (46.00)	54 (54.00)	147 (39.73)	123 (33.24)	100 (27.03)	165 (44.59)	205 (55.41)	370 (14.00)
Quadruplets or more	132	33	5 (83.33)	1 (16.67)	5 (41.67)	7 (58.33)	4 (25.00)	12 (75.00)	6 (17.65)	12 (33.24)	16 (47.06)	14 (41.18)	20 (58.82)	34 (25.76)
Total	6642	3205	134	162	104	175	96	147	296	279	243	334	484	818

B, Buckling; D, Doeling; Figure in parenthesis indicate percentage.

Table 3. Kid mortality according to parity of dam in different agro-climatic regions

Parity	Birth			Hill		Terai		Lower Gangetic plain		Sub Total			Total		
	B	D	Total	B(a)	D(b)	B(c)	D(d)	B(e)	D(f)	Hill (a+b)	Terai (c+d)	Lower Gangetic plain (e+f)	B (a+c+e)	D (b+d+f)	Total
PTY-1	354	290	644	5 (23.81)	16 (76.19)	4 (21.05)	15 (78.95)	3 (27.27)	8 (72.73)	21 (41.18)	19 (37.25)	11 (21.57)	12 (23.53)	39 (76.47)	51 (6.24)
PTY-2	509	571	1080	16 (41.03)	23 (58.97)	12 (35.29)	22 (64.71)	16 (45.71)	19 (54.29)	39 (36.11)	34 (31.48)	35 (32.41)	44 (40.74)	64 (59.26)	108 (13.20)
PTY-3	623	602	1225	36 (52.17)	33 (47.83)	19 (45.24)	23 (54.76)	12 (35.29)	22 (64.71)	69 (47.59)	42 (28.97)	34 (23.45)	67 (46.21)	78 (53.79)	145 (17.73)
PTY-4	671	621	1292	25 (46.30)	29 (53.70)	16 (34.04)	31 (65.96)	21 (43.75)	27 (56.25)	54 (36.24)	47 (31.54)	48 (32.21)	62 (41.61)	87 (58.39)	149 (18.22)
PTY-5	625	579	1204	26 (44.83)	32 (55.17)	27 (42.86)	36 (57.14)	17 (36.17)	30 (63.83)	58 (34.52)	63 (37.50)	47 (27.98)	70 (41.67)	98 (58.33)	149 (20.54)
PTY-6	569	628	1197	26 (47.27)	29 (52.73)	26 (35.14)	48 (64.86)	27 (39.71)	41 (60.29)	55 (27.92)	74 (37.56)	68 (34.52)	79 (40.10)	118 (59.90)	197 (24.08)
TOTAL	3351	3291	6642	134	162	104	175	96	147	296	279	243	334	448	818

B, Buckling; D, Doeling; Figure in parenthesis indicate percentage. Percentage of buckling or doeling was calculated in respect to the sub-total or total of the region. Relative percentage of total column was calculated in respect to total kid mortality.

(Petros *et al.* 2014). Infectious causes (i.e. diarrhoea, pneumonia, bloat and enterotoxaemia and ecthyma) followed by predators, mechanical and congenital were the main reasons for kid mortality (Ershaduzzaman *et al.* 2007).

The unknown reasons of kid mortality might be due to certain infectious diseases which has caused highest mortality of kids. High mortality of kids due to unknown reasons shows that farmers might be ignorant to the various infectious diseases of goat. Moreover, the study had also pointed out poor management under family-based farming system where it can be seen that higher mortality of kids due to death of doe, predator attack, chilling cold and rain.

Table 4 shows the economic loss of about ₹ 531/ kid and ₹ 1,447/goat farmers and overall total financial losses due to kid mortality at pre-weaning age were more than ₹ 4.34 lakhs during the study period. Highest economic losses were recorded for unknown reasons (₹ 68,900) followed by doe died (₹ 59,280), diarrhea (₹ 58,530) and pneumonia (₹ 55,300). Roy *et al.* (2015) reported that mortality loss in goat under field condition due to major diseases were PPR (₹ 2,558), goat pox (₹ 2,406), haemorrhagic septicaemia (₹ 2,477), kid diarrhea (₹ 500) FMD (₹ 2,273) and enterotoxaemia (₹ 2,427).

SUMMARY

The aim of the study was to assess the pre-weaning kid mortality patterns and financial losses under family-based farming system. To achieve the objective, an *ex-post facto* study was designed with 300 randomly selected respondents from three agro-climatic situation of West Bengal. The study

Table 4. Economic loss (₹ '000) due to major factors

Economic loss (₹ '000) due to major factor	Hill			Terai			Lower Gangetic plain			Economic loss	Economic loss per kid
	Buckling	Doeling	Sub-Total	Buckling	Doeling	Sub-Total	Buckling	Doeling	Sub-Total		
Pneumonia	9.54	13.58	23.12	9.89	11.89	21.78	4.12	6.28	10.40	55.30	0.507
Diarrhea	9.01	4.69	13.70	14.21	10.78	24.99	11.03	8.81	19.84	58.53	0.518
Anorexia	5.41	7.88	13.29	6.34	6.52	12.86	2.66	10.49	13.15	39.30	0.524
Goat pox	0.65	3.83	4.48	2.87	3.29	6.16	1.56	0	1.56	12.20	0.581
Doe died	9.56	12.89	22.45	8.95	13.68	22.63	4.93	9.27	14.20	59.28	0.529
Miss mothering	4.89	5.89	10.78	4.92	4.31	9.23	1.15	6.99	8.14	28.15	0.563
Chilling cold	5.11	5.79	10.90	3.55	2.87	6.42	9.43	7.63	17.06	34.38	0.563
Rain	4.33	8.55	12.88	0.55	5.93	6.48	2.05	6.94	8.99	28.35	0.567
Predator	10.01	9.15	19.16	2.79	6.07	8.86	10.20	11.41	21.61	49.63	0.534
Unknown	14.38	13.99	28.37	2.13	23.56	25.69	4.62	10.22	14.84	68.90	0.510
Total	72.89	86.24	159.13	56.2	88.90	145.10	51.75	78.04	129.79	434.02	0.531

covered 3,205 kidding with 6,642 kids born. The total pre-weaning kid mortality was 12.32% whereas the relative percentage of mortality was highest (36.19%) in hill agro-climatic followed by terai region (34.11%) and lower Gangetic plain (29.71%). The pattern of pre-weaning kid mortality showed that mortality was higher in doeling than bucking and highest within a month whereas maximum mortality was within 1st week. Kid mortality was significantly higher during winter months. Mortality was highest in kid having less than 1 kg birth weight, in case of quadruplet birth or more and kid born in 6th parity order. Major reasons of kid mortality were unknown followed by diarrhea, doe died, pneumonia and predator attack. The study shows an economic loss of about ₹531 per kid and ₹1447 per goat farmers and overall financial losses due to pre-weaning kid mortality were more than ₹4.34 lakhs during the study period. The pre-weaning kid mortality and economic losses to these farmers can be further reduced through better management practices, prenatal and postpartum healthcare practices of the doe and pre-weaned kid.

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